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Monthly Performance Report

FEB 19 1980

PADONIA SCHOOL

MAY 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT
PADONIA SCHOOL
MAY 1979

I. SYSTEM DESCRIPTION

The Padonia School site is a one-story 45,000 square foot elementary school in Cockeyville, Maryland. Its solar energy system is designed to provide 75 percent of the space heating and cooling required for the cafetorium, library, and administrative suite, a total area of 10,000 square feet. The energy collection subsystem consists of three 420-square foot, liquid filled, movable collectors, and three 1,044 square-foot stationary parabolic reflectors mounted on the roof facing south. The reflectors have a chord angle of 20 degrees from horizontal, and the movable collectors track the elevation of the sun about an east-west axis. Collected energy is stored in 9,300 gallons of hot water storage. Space cooling is provided by an absorption cycle chiller powered by solar heated water. The chiller removes energy from 9,700 gallons of cold water storage. Both the hot water and cold water storage tanks are insulated with 6 inches of polyurethane foam and buried in the ground.

The system interconnects with the existing air-handler unit water-to-air heat exchanger coils. Auxiliary space heating and cooling is supplied by the school's existing heating, cooling, and ventilating equipment. Manually operated gate valves are located in the load subsystem's hot and cold water supply and return lines to provide for either winter or summer operation. For winter operation, the hot water supply and return lines are opened and the cold water lines are closed. For summer operation, the hot water lines are closed and the cold water lines are opened.

The system, shown schematically in Figure 1, has two modes of winter operation and five modes for summer operation.

A. Winter Operation

Mode 1 - Collector-to-Conditioned Space and Storage: Operation begins when the collector surface temperature is 10°F higher than the temperature

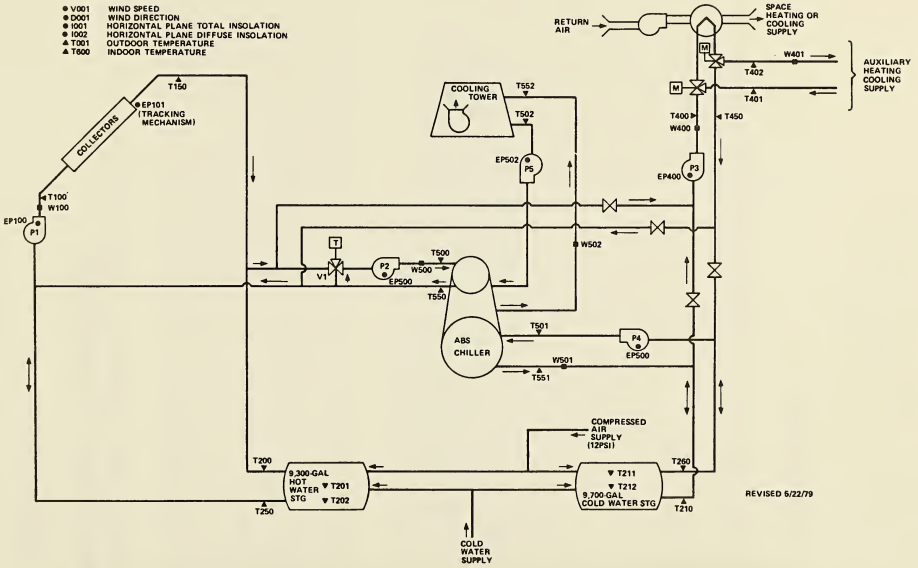

Figure 1. PADONIA ELEMENTARY SCHOOL SOLAR ENERGY SYSTEM SCHEMATIC

at the bottom of hot water storage. Water is circulated from the storage tank through the collector array by pump P1 and returned to storage. A five-minute delay inhibits turn-off to prevent undesirable cycling.

The collectors are automatically positioned prior to pump operation, and are controlled at one-minute intervals to stay in the focal plane determined by the sun's elevation with respect to the reflector surface.

When a space heating demand exists and the temperature at the top of hot water storage is above 110°F, water heated by the collectors is transferred to the water-to-air heat exchangers in the air-handler units by pumps P1 and P3. The water leaving the air-handler units is returned to the collectors. Collector operation continues until the temperature difference between the collector surface and storage is less than 1°F.

Mode 2 - Storage-to-Load: This mode is entered when a space heating demand exists, the temperature at the top of hot water storage is above 110°F, and the collector loop is not on. Hot water is transferred by pump P3 from hot water storage to the water-to-air heat exchangers located in the air-handler units and back to storage.

B. Summer Operation

Mode 1 - Collector-to-Chiller and Storage: Operation in this mode begins when the collector surface temperature is 10°F above the temperature at the bottom of hot water storage. Water from storage is circulated through the collectors by pump P1 and returned to storage. When the collector outlet temperature is above 185°F and the temperature at the top of cold water storage is above 40°F, hot water from the collector is directed to the solar-driven generator of the absorption cycle chiller by pump P2 and returned to the collector. A portion of the return water from the generator may be shunted back to the chiller supply by mixing valve V1 to maintain a maximum supply temperature of 195°F. Collector operation continues until the temperature difference between the collector surface and hot water storage is less than 1°F.

Mode 2 - Hot Water Storage-to-Chiller: Operation in this mode is selected whenever the temperature at the top of hot water storage is above 185°F, the temperature at the top of cold water storage is above 40°F, and the collector is not on. Water is transferred from hot water storage to the absorption cycle chiller by pump P2 and returned to storage. Mixing valve V1 is thermostatically controlled to maintain solar-heated water supplying the chiller below 195°F.

Mode 3 - Chiller-to-Conditioned Space: This mode is entered whenever there is a space cooling demand and the input requirements of the chiller are satisfied. Cooled water is transferred from the chiller directly to the air-handler units by pumps P3 and P4 and returned to the chiller.

Mode 4 - Cold Water Storage-to-Conditioned Space: This mode is entered when a space cooling demand exists, the chiller is not providing chilled water, and the water at the bottom of cold water storage is cold enough to supply the space cooling demand. Water is transferred from cold water storage to the air-handler units by pump P3 and returned to storage.

Mode 5 - Chiller-to-Cold Water Storage: If solar heated water is available to drive the chiller and no space cooling demand exists, the water from cold water storage is circulated through the chiller evaporator coils by pump P4 and returned to storage.

II. PERFORMANCE EVALUATION

The system performance evaluations discussed in this section are based primarily on the analysis of the data presented in the attached computer-generated monthly report. This attached report consists of daily site thermal and energy values for each subsystem, plus environmental data. The performance factors discussed in this report are based upon the definitions contained in NBSIR 76-1137, Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program.

A. Introduction

The Padonia School solar energy system was operational during May and provided 98 percent of the space heating demand. The system collected a total of 15.3 million Btu and delivered 2.8 million Btu to space heating. Space cooling was supplied totally by the auxiliary cooling source. The conventional system supplied 0.1 million Btu to the space heating demand, and 6.4 million Btu to the space cooling demand. The solar energy system was manually switched over from space heating to space cooling on May 7.

B. Weather

The long-term average daily outside ambient temperature for May recorded at Baltimore-Washington International Airport, was 63°F. Average daily temperature measured at Padonia School ranged from 54°F to 76°F, and the average for the month was 64°F.

The long-term total solar insolation for May was 1,713 Btu/ft^2-day. The measured total insolation was 1,432 Btu/ft^2-day, and the measured diffuse insolation was 602 Btu/ft^2-day.

C. System Thermal Performance

Collector - Of the 139.0 million Btu of solar energy incident on the horizontal plane of the collector array, 84.5 million Btu were available during collector operation, and 15.3 million Btu were collected. The operation of the collector pump and tracking equipment required 1.2 million Btu (353 kwh) of electrical energy. The measured collector array efficiency was 11 percent.

Concentrating collectors primarily make use of the beam component of the total radiation. In May, the ratio of total to diffuse radiation was 2.3. This ratio varied from 1.1:1 on May 13, to 6.3:1 on May 5.

Storage - Of the 15.3 million Btu of solar energy collected, 12.8 million Btu were delivered to storage and 1.8 million Btu were lost between the collectors and storage. (The remaining 0.7 million Btu were delivered

directly to the heating load.) Of the 12.8 million Btu delivered to storage, 3.6 were removed to satisfy heating and cooling requirements and 7.2 were lost from the tank, leaving an increase in stored energy of 2.0 million Btu for the month. The storage temperature increased from 141°F at the beginning of the month to 164°F at the end. The calculated monthly storage efficiency was 44 percent.

Space Heating Load - The space heating subsystem operated the first week of May and again on May 17, requiring 2.8 million Btu of solar energy and 0.06 million Btu of auxiliary energy. Assuming 60 percent boiler efficiency, the auxiliary fossil fuel demand for May was 0.1 million Btu. The average ambient temperature of the conditioned spaces was maintained at 72°F.

Space Cooling Load - The solar space cooling subsystem was operated on May 22, 23 and 29 in a check-out mode, but was not operational. The check-out activity was terminated due to insufficient solar insolation to maintain hot water storage above the 185°F operating temperature. Auxiliary space cooling equipment removed 6.4 million Btu from the conditioned spaces. Assuming a coefficient of performance of 2.5, the auxiliary electrical energy demand for cooling was 2.6 million Btu (755 Kwh).

D. Observations

Of the 15.3 million Btu of solar energy collected, 2.8 million Btu were delivered to the space heating load, 2.0 million were included in the net storage energy gain, and 10.5 million Btu were the net energy loss. The losses were distributed as follows: 1.8 million Btu between the collector and storage, 7.2 million Btu from storage to surroundings, and 1.5 million Btu between the energy collection and storage subsystem and load.

Although load flow occurred during evenings and weekends, the temperature difference across the load was less than 1°F, indicating no space heating demand. The small temperature differences may have resulted in some inaccuracies in the measured load.

E. Energy Savings

Fossil energy savings of 4.6 million Btu were measured in May. This is equivalent to the amount of fossil fuel energy required if the solar energy system were replaced by a 60-percent efficient boiler. The solar energy system operated at a cost of 2.1 million Btu of electrical energy (608 Kwh).

III. ACTION STATUS

An inaccurate collector temperature sensor has been identified and a site visit will be scheduled to resolve the problem. This inaccuracy does not affect the results of this report.

The solar space cooling subsystem check-out will continue when favorable solar insolation is available to raise the storage tank to operating temperature.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: PADONIA SCHOOL COCKEYVILLE,MD. SOLAR/2035-79/05
REPORT PERIOD: MAY,1979

SITE/SYSTEM DESCRIPTION:
THE PADONIA SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND SPACE COOLING. SOLAR HEATED WATER FROM THE COLLECTORS OR FROM STORAGE IS DIRECTED TO IN-DUCT HEAT EXCHANGERS FOR SPACE HEATING. SOLAR HEATED WATER IS DIRECTED TO THE GENERATOR LOOP OF AN ARKLA CHILLER. EXISTING SCHOOL EQUIPMENT PROVIDES AUXILIARY HEATING AND COOLING.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	139.043 MILLION BTU
	44394 BTU/SQ.FT.
COLLECTED SOLAR ENERGY	15.285 MILLION BTU
	4880 BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	64 DEGREES F
AVERAGE BUILDING TEMPERATURE	72 DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.02
ECSS OPERATING ENERGY	1.205 MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	2.076 MILLION BTU
TOTAL ENERGY CONSUMED	20.035 MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	2.831	6.438	9.270 MILLION BTU
SOLAR FRACTION	N.A.	98	0	30 PERCENT
SOLAR ENERGY USED	N.A.	2.773	0.211	2.984 MILLION BTU
OPERATING ENERGY	N.A.	0.843	0.028	2.076 MILLION BTU
AUX. THERMAL ENERGY	N.A.	0.059	6.438	6.497 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	2.575	2.575 MILLION BTU
AUX. FOSSIL FUEL	N.A.	0.098	N.A.	0.098 MILLION BTU
ELECTRICAL SAVINGS	N.A.	-0.843	-0.028	-2.076 MILLION BTU
FOSSIL SAVINGS	N.A.	4.621	N.A.	4.621 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.595

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: PADONIA SCHOOL COCKEYVILLE,MD. SOLAR/2035-79/05
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GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	146.691 GIGA JOULES
	504143 KJ/SQ.M.
COLLECTED SOLAR ENERGY	16.126 GIGA JOULES
	55420 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	18 DEGREES C
AVERAGE BUILDING TEMPERATURE	22 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.02
ECSS OPERATING ENERGY	1.271 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	2.191 GIGA JOULES
TOTAL ENERGY CONSUMED	21.137 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	2.987	6.792	9.779 GIGA JOULES
SOLAR FRACTION	N.A.	98	0	30 PERCENT
SOLAR ENERGY USED	N.A.	2.925	0.223	3.148 GIGA JOULES
OPERATING ENERGY	N.A.	0.889	0.030	2.191 GIGA JOULES
AUX. THERMAL ENG	N.A.	0.062	6.792	6.854 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	2.717	2.717 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	0.104	N.A.	0.104 GIGA JOULES
ELECTRICAL SAVINGS	N.A.	-0.889	-0.030	-2.191 GIGA JOULES
FOSSIL SAVINGS	N.A.	4.875	N.A.	4.875 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.595

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

4292

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: PADONIA SCHOOL COCKEYVILLE,MD. SOLAR/2035-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	7.117	57	0.227	N	0.089	N	0.011
2	6.679	55	0.660	O	0.078	O	0.087
3	2.620	63	0.956	T	0.009	T	0.294
4	2.216	61	0.790		0.005		0.315
5	7.267	55	0.253	A	0.094	A	0.011
6	5.415	56	0.354	P	0.066	P	0.027
7	6.757	66	0.077	P	0.078	P	0.003
8	6.550	71	0.000	L	0.067	L	0.000
9	6.774	74	0.000	I	0.082	I	0.000
10	5.600	76	0.000	C	0.053	C	0.000
11	5.348	76	0.300	A	0.050	A	0.000
12	1.122	66	0.000	B	0.000	B	0.000
13	1.134	67	0.000	L	0.000	L	0.000
14	2.411	61	0.000	E	0.017	E	0.000
15	6.268	64	0.000		0.074		0.000
16	7.467	60	0.000		0.086		0.000
17	7.194	59	0.753		0.075		0.055
18	2.548	59	0.000		0.003		0.000
19	5.549	65	0.000		0.056		0.000
20	2.819	63	0.000		0.009		0.000
21	1.768	63	0.000		0.002		0.000
22	4.068	66	0.003		0.012		0.001
23	2.325	67	0.208		0.003		0.089
24	3.420	66	0.000		0.028		0.000
25	4.063	61	0.000		0.029		0.000
26	4.108	54	0.000		0.011		0.000
27	3.280	61	0.000		0.000		0.000
28	3.132	59	0.000		0.000		0.000
29	5.419	64	0.001		0.055		0.000
30	6.225	67	0.000		0.068		0.000
31	2.380	67	0.000		0.005		0.000
SUM	139.043	-	4.281	N.A.	1.205	N.A.	-
AVG	4.485	64	0.138	N.A.	0.039	N.A.	0.021
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4292

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: PADONIA SCHOOL COCKEYVILLE,MD. SOLAR/2035-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	7.117	6.145	1.272	63	0.179
2	6.679	5.774	1.265	67	0.189
3	2.620	0.526	0.041	70	0.016
4	2.216	0.097	0.000	67	0.000
5	7.267	6.161	1.297	60	0.179
6	5.415	4.242	0.558	68	0.103
7	6.757	5.688	1.323	75	0.196
8	6.550	5.337	1.076	82	0.164
9	6.774	5.741	1.329	85	0.196
10	5.600	4.116	0.594	85	0.106
11	5.348	3.894	0.514	86	0.096
12	1.122	0.000	0.000	68	0.000
13	1.134	0.000	0.000	70	0.000
14	2.411	0.991	0.045	63	0.018
15	6.268	4.965	0.814	76	0.130
16	7.467	6.222	1.309	70	0.175
17	7.194	5.648	1.027	71	0.143
18	2.548	0.000	0.000	67	0.000
19	5.549	4.268	0.825	73	0.149
20	2.819	0.454	0.008	68	0.003
21	1.768	0.000	0.000	67	0.000
22	4.068	0.519	0.017	72	0.004
23	2.325	0.061	0.000	73	0.000
24	3.420	1.876	0.325	71	0.095
25	4.063	1.975	0.243	68	0.060
26	4.108	1.374	0.000	58	0.000
27	3.280	0.000	0.000	67	0.000
28	3.132	0.000	0.000	66	0.000
29	5.419	3.730	0.726	74	0.134
30	6.225	4.547	0.679	76	0.109
31	2.380	0.140	0.000	72	0.000
SUM	139.043	84.491	15.285	-	-
AVG	4.485	2.726	0.493	71	0.110
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4292

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: PADONIA SCHOOL COCKEYVILLE,MD. SOLAR/2035-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.981	0.203	0.952	141	1.177
2	0.990	0.533	0.084	147	0.623
3	0.007	0.912	-1.079	141	-22.596
4	0.000	0.789	-0.999	127	1.000
5	0.822	0.214	1.243	129	1.772
6	0.303	0.289	0.201	139	1.616
7	1.267	0.077	0.992	146	0.844
8	1.035	0.000	0.599	157	0.579
9	1.279	0.000	0.922	168	0.721
10	0.563	0.000	0.219	176	0.389
11	0.473	0.000	0.031	177	0.066
12	0.000	0.000	-0.167	177	1.000
13	0.000	0.000	-0.146	175	1.000
14	0.041	0.000	-0.387	171	-9.411
15	0.762	0.000	0.419	172	0.549
16	1.260	0.000	0.897	180	0.712
17	0.364	0.404	-0.104	186	0.824
18	0.000	0.000	-0.177	185	1.000
19	0.808	0.000	0.271	185	0.335
20	0.007	0.000	-0.323	185	-45.923
21	0.000	0.000	-0.167	181	1.000
22	0.018	0.003	-0.480	177	-27.142
23	0.000	0.208	-0.534	170	1.000
24	0.307	0.000	0.126	167	0.409
25	0.235	0.000	-0.126	166	-0.534
26	0.000	0.000	-0.063	165	1.000
27	0.000	0.000	-0.189	164	1.000
28	0.000	0.000	-0.063	162	1.000
29	0.687	0.001	0.032	161	0.047
30	0.626	0.000	0.315	164	0.503
31	0.000	0.000	-0.273	164	1.000
SUM	12.835	3.631	2.026	-	-
AVG	0.414	0.117	0.065	165	0.441
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4292

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: PADONIA SCHOOL COCKEYVILLE,MD.
REPORT PERIOD: MAY,1979

SOLAR/2035-79/05

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.078	100	0.078	0.099	0.000	N	0.000	-0.099	0.130	72	57
2	0.639	91	0.580	0.112	0.059	O	0.098	-0.112	0.966	73	55
3	0.770	100	0.770	0.152	0.000	T	0.000	-0.152	1.283	74	63
4	0.698	100	0.698	0.142	0.000		0.000	-0.142	1.164	74	61
5	0.083	100	0.083	0.119	0.000	A	0.000	-0.119	0.139	71	55
6	0.145	100	0.145	0.122	0.000	P	0.000	-0.122	0.242	68	56
7	0.023	100	0.023	0.048	0.000	P	0.000	-0.048	0.038	71	66
8	0.000	0	0.000	0.000	0.000	L	0.000	0.000	0.000	74	71
9	0.000	0	0.000	0.000	0.000	I	0.000	0.000	0.000	77	74
10	0.000	0	0.000	0.000	0.000	C	0.000	0.000	0.000	79	76
11	0.000	0	0.000	0.000	0.000	A	0.000	0.000	0.000	77	76
12	0.000	0	0.000	0.000	0.000	B	0.000	0.000	0.000	73	66
13	0.000	0	0.000	0.000	0.000	L	0.000	0.000	0.000	68	67
14	0.000	0	0.000	0.000	0.000	E	0.000	0.000	0.000	67	61
15	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	68	64
16	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	70	60
17	0.395	100	0.395	0.050	0.000		0.000	-0.050	0.659	70	59
18	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	70	59
19	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	69	65
20	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	69	63
21	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	69	63
22	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	70	66
23	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	72	67
24	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	74	66
25	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	73	61
26	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	72	54
27	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	70	61
28	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	71	59
29	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	71	64
30	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	72	67
31	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	74	67
SUM	2.831	-	2.773	0.843	0.059	N.A.	0.098	-0.843	4.621	-	-
AVG	0.091	98	0.089	0.027	0.002	N.A.	0.003	-0.027	0.149	72	64
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4292

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE COOLING SUBSYSTEM

SITE: PADONIA SCHOOL COCKEYVILLE,MD.
REPORT PERIOD: MAY,1979

SOLAR/2035-79/05

DAY OF MON.	SPACE COOLING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG DRY BULB TEMP F	AMB TEMP DEG F
1	0.000	0	0.000	0.000	0.000	0.000	N	0.000	N	72	57
2	0.000	0	0.000	0.000	0.000	0.000	O	0.000	O	73	55
3	0.000	0	0.000	0.000	0.000	0.000	T	0.000	T	74	63
4	0.000	0	0.000	0.000	0.000	0.000		0.000		74	61
5	0.000	0	0.000	0.000	0.000	0.000	A	0.000	A	71	55
6	0.000	0	0.000	0.000	0.000	0.000	P	0.000	P	68	56
7	0.018	0	0.000	0.000	0.018	0.007	P	0.000	P	71	66
8	0.123	0	0.000	0.000	0.123	0.049	L	0.000	L	74	71
9	0.226	0	0.000	0.000	0.226	0.090	I	0.000	I	77	74
10	0.376	0	0.000	0.000	0.376	0.151	C	0.000	C	79	76
11	0.728	0	0.000	0.000	0.728	0.291	A	0.000	A	77	76
12	1.233	0	0.000	0.000	1.233	0.493	B	0.000	B	73	66
13	1.016	0	0.000	0.000	1.016	0.406	L	0.000	L	68	67
14	0.553	0	0.000	0.000	0.553	0.221	E	0.000	E	67	61
15	0.542	0	0.000	0.000	0.542	0.217		0.000		68	64
16	0.128	0	0.000	0.000	0.128	0.051		0.000		70	60
17	0.341	0	0.000	0.000	0.341	0.136		0.000		70	59
18	0.613	0	0.000	0.000	0.613	0.245		0.000		70	59
19	0.205	0	0.000	0.000	0.205	0.082		0.000		69	65
20	0.181	0	0.000	0.000	0.181	0.072		0.000		69	63
21	0.105	0	0.000	0.000	0.105	0.042		0.000		69	63
22	0.040	0	0.003	0.008	0.040	0.016		-0.008		70	66
23	0.006	0	0.208	0.017	0.006	0.002		-0.017		72	67
24	0.000	0	0.000	0.000	0.000	0.000		0.000		74	66
25	0.000	0	0.000	0.000	0.000	0.000		0.000		73	61
26	0.000	0	0.000	0.000	0.000	0.000		0.000		72	54
27	0.000	0	0.000	0.000	0.000	0.000		0.000		70	61
28	0.005	0	0.000	0.000	0.005	0.002		0.000		71	59
29	0.000	0	0.001	0.002	0.000	0.000		-0.002		71	64
30	0.000	0	0.000	0.000	0.000	0.000		0.000		72	67
31	0.000	0	0.000	0.000	0.000	0.000		0.000		74	67
SUM	6.438	-	0.211	0.028	6.438	2.575	N.A.	-0.028	N.A.	-	-
AVG	0.208	0	0.007	0.001	0.207	0.083	N.A.	-0.001	N.A.	72	64
NBS	Q502	N500	Q500	Q503	Q501		Q508	Q512	Q514	N406	N113

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4292

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: PADONIA SCHOOL COCKEYVILLE,MD.
REPORT PERIOD: MAY,1979

SOLAP/2035-79/05

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	2272	399	57	63	N	302	4
2	2132	478	55	67	O	0	1
3	837	557	63	70	T	195	5
4	707	528	61	67		311	3
5	2320	368	55	60	A	327	3
6	1729	771	56	68	P	159	2
7	2157	454	66	75	P	162	3
8	2091	605	71	82	L	161	3
9	2163	382	74	85	I	196	3
10	1788	725	76	85	C	0	2
11	1708	728	76	86	A	0	2
12	358	312	66	68	B	0	2
13	362	321	67	70	L	0	1
14	770	572	61	63	E	0	2
15	2001	699	64	76		0	2
16	2384	449	60	70		333	3
17	2297	533	59	71		18	2
18	814	665	59	67		34	3
19	1772	674	65	73		73	3
20	900	701	63	68		0	1
21	564	494	63	67		0	2
22	1299	837	66	72		0	1
23	742	599	67	73		164	2
24	1092	626	66	71		227	4
25	1297	765	61	68		0	2
26	1312	897	54	58		245	3
27	1047	708	61	67		0	1
28	1000	707	59	66		0	1
29	1730	670	64	74		0	1
30	1987	805	67	76		0	2
31	760	647	67	72		0	1
SUM	44394	18677	-	-	-	-	-
AVG	1432	602	64	71	N.A.	*	2
NBS ID	Q001		N113			N115	N114

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4292

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
THERMODYNAMIC CONVERSION EQUIPMENT

SITE: PADONIA SCHOOL COCKEYVILLE,MD. SOLAR/2035-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	EQUIPMENT LOAD MILLION BTU	THERMAL ENERGY INPUT MILLION BTU	OPERATING ENERGY MILLION BTU	ENERGY REJECTED MILLION BTU	COEFFICIENT OF PERFORMANCE (SEE NOTE)
1	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000
22	0.000	0.003	0.008	0.182	0.000
23	0.021	0.208	0.017	0.132	0.102
24	-0.019	0.000	0.002	0.042	0.000
25	0.000	0.000	0.007	0.194	0.000
26	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000
29	-0.002	0.001	0.002	0.000	-2.182
30	0.000	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000	0.000
SUM	0.001	0.211	0.037	0.551	0.004
AVG	0.000	0.007	0.001	0.018	0.000

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NOTE:

4292

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
AUXILIARY STORAGE PERFORMANCE

SITE: PADONIA SCHOOL COCKEYVILLE,MD. SOLAR/2035-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	INCREASE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.000	0.000	0.029	60	1.000
2	0.000	0.000	-0.029	60	1.000
3	0.000	0.000	0.015	60	1.000
4	0.000	0.000	0.029	60	1.000
5	0.000	0.000	-0.005	60	1.000
6	0.000	0.000	-0.015	60	1.000
7	0.000	0.000	0.024	60	1.000
8	0.000	0.000	-0.010	60	1.000
9	0.000	0.000	-0.005	60	1.000
10	0.000	0.000	0.024	60	1.000
11	0.000	0.000	0.000	60	1.000
12	0.000	0.000	0.034	61	1.000
13	0.000	0.000	0.005	61	1.000
14	0.000	0.000	0.020	61	1.000
15	0.000	0.000	0.034	61	1.000
16	0.000	0.000	-0.005	61	1.000
17	0.000	0.000	-0.005	61	1.000
18	0.000	0.000	0.029	62	1.000
19	0.000	0.000	0.005	62	1.000
20	0.000	0.000	0.024	62	1.000
21	0.000	0.000	0.005	62	1.000
22	0.000	0.000	-0.029	62	1.000
23	0.000	0.008	0.039	62	-4.656
24	0.000	0.012	0.029	63	-2.543
25	0.000	0.000	0.039	63	1.000
26	0.000	0.000	0.015	63	1.000
27	0.000	0.000	-0.000	63	1.000
28	0.000	0.000	0.015	63	1.000
29	0.000	0.002	0.024	64	-12.209
30	0.000	0.000	0.015	64	1.000
31	0.000	0.000	0.015	64	1.000
SUM	0.000	0.022	0.367	-	-
AVG	0.000	0.001	0.012	61	-16.715

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4292

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